DØ RECO Status

ADM, Feb. 2, 2001

Harry Melanson

RECO: Global reconstruction program

- *Stages*:
  - Unpack detector data
  - Detector reconstruction (clusters, hits, etc.)
    - SMT, CFT, CPS, FPS, MUO
  - Find global tracks
    - CFT, SMT
  - Find vertices
    - Primary, secondary
  - Perform standard particle ID
    - CAL, charged particles
    - EM (e / γ), muon, tau, jets, MET

Output:
"EDU (really big)"
A lot of chunks…

RECO is developed by Algorithms / Object ID groups

Algorithm group leaders

Level 3 - Amber Boehnlein, Dan Claes

Alignment/Calibration - John Hobbs, Taka Yasuda

Silicon Tracker - Emanuela Barberis

Fiber Tracker - Mike Hildreth

Calorimeter/Preshowers - Lee Sawyer

Muon System - Pushpa Bhat, Christophe Royon

Global Tracking - David Adams, Herbert Greenlee

Vertex finding - Suyong Choi, Guilherme Lima

Object ID group leaders

Electrons / photons - Ron Madaras, Michel Jaffre

Muons - Daria Zieminska, Dave Hedin

Taus - Qizhong Li, Paul Padley

Jets and Missing ET - Laurent Duflot, Bob Hirosky

Heavy Flavor (b and c) - Alice Bean, Rick Van Kooten

Algorithms Web Page:

Follow:
D0 at work
Computing
Algorithms

http://www-d0.fnal.gov/computing/algorithms/

Find links to individual group web pages.

Find link to Developer's Corner (for RECO developers)

Note link to Schedule for next RECO production release

click

Find link to User's Corner (for users of RECO)

Note link to Reco Status.

We make "quarterly" releases

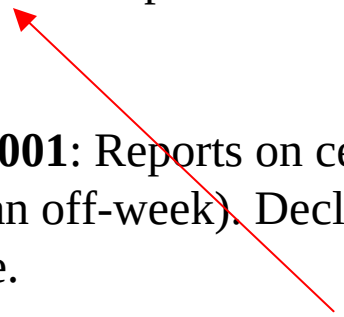
Schedule for D0RECO Production Release P08

• **January 8, 2001**: All MAJOR improvements to be included in p08 MUST be released in the test build of the week of January 8. Any major modifications that miss this date will be targeted for next production release (~ May, 2001). Note that the next production release occurs AFTER roll-in.

• **January 22, 2001**: No new functionality will be allowed in the test build of the week of January 22. Only bug / mistake fixes will be allowed in this build. (and there better not be many...)

• **February 5, 2001**: Production version is created, and formal certification begins. Algorithm groups will report on certification studies at the February 23 Algorithms meeting.

• **February 23, 2001**: Reports on certification samples at a SPECIAL Algorithms meeting (during an off-week). Declaration of the production worthiness of executable will then be made.



We're right in the middle of it now…

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Changes since previous version of RECO

- **General**
  - Cleanup of error messages (use ErrorLogger).
  - Addition of general statistics package (recostat).
  - Support for Raw Data Chunk produced by p07 Monte Carlo.
  - New versioning implementation for detector geometries.
  - System to handle “non-standard” readout configurations
- **Detectors**
  - **CFT**
    - Support for distortions to describe as-built geometry.
  - **CPS**
    - New method for finding preshower energy in cone (eCone).
    - Basic handling of saturated strips.
    - Tuned parameters.
  - **CAL**
    - Use pmc02 derived, eta-indep, cal-only weights (CPS not included).
    - Fix problem with handling zero energy towers.

❖ Global Tracking

- ❖ Turn on overlap tracking.
- ❖ Use non-uniform magnetic field for track finding in the overlap region, and for refitting in overlap and central region.
- ❖ Better accounting for CFT cluster errors in an attempt to solve the CFT efficiency drop-off with increasing number of background events.
- ❖ Better (more efficient) SMT extension paths.
- ❖ Numerous speed-ups and optimizations.
  - ❖ CFT central tracking has been split into separate axial and stereo steps.
  - ❖ SMT geometry has been optimized (speeds up refit).
  - ❖ Various computer science optimizations (static linear algebra, local reference count smart pointers, cluster containers).

- **Vertexing**
  - Primary vertexing
    - Single track vertexing
    - Better selection
      - Minimum track PT-sum of 5 GeV, to remove spurious vertices
      - Ability to choose maximum multiplicity vertex as PV
      - Better min. bias separation from hard scatter vtx
  - Secondary vertexing
    - Kalman vertexing
      - Track clustering
      - x40 speed-up
    - Secondary vertexing
      - Better seeds
      - Speed-up

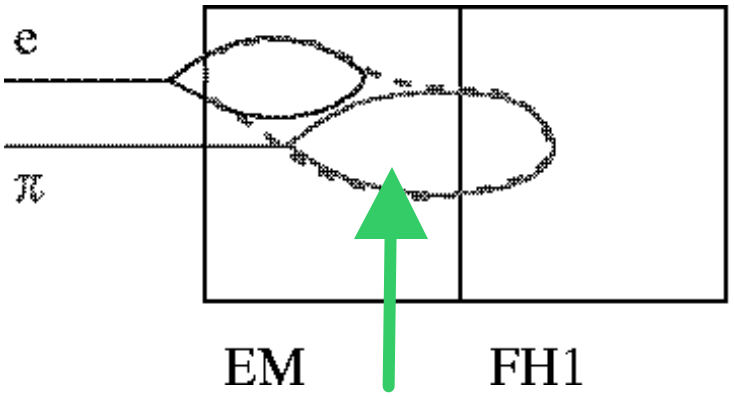
- **EM ID**
  - Implement "road method" in SEMRECO (not yet used to identify electrons)
  - Fix bug in CellNN that generated zero energy clusters
  - Protect against crashes from zero energy clusters.
- **Muon ID**
  - New chunk: Muon:SegmentChunk
  - New segment object:
    - Knows its position, direction, and errors
    - Knows matching scintillator time
    - Methods for retrieving PDT, MDT and MSC hits
    - Method for a linear propagation to facilitate matching with calorimeter and central track.
    - Not yet used in muon id (scheduled for p09)
  - New segment finding algorithm: LinkedList (now default)
  - Local track fitting upgraded (WAMUS and FAMUS)

EM ID

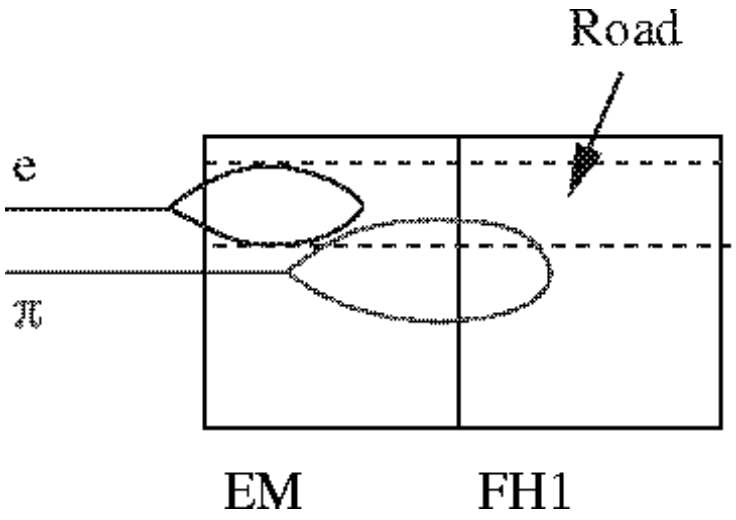
Why a Road method ?

Aim : tagging soft electrons close to/in b/c jets.

Clusters :



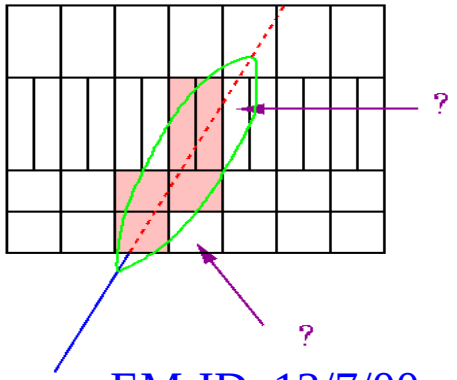
Road :



One cluster, not purely EM

→ Try to keep as much information (energy) as possible.
The width of the Road has to be adjusted to signal.

→ Road based on the extrapolation of the track through the calorimeter.



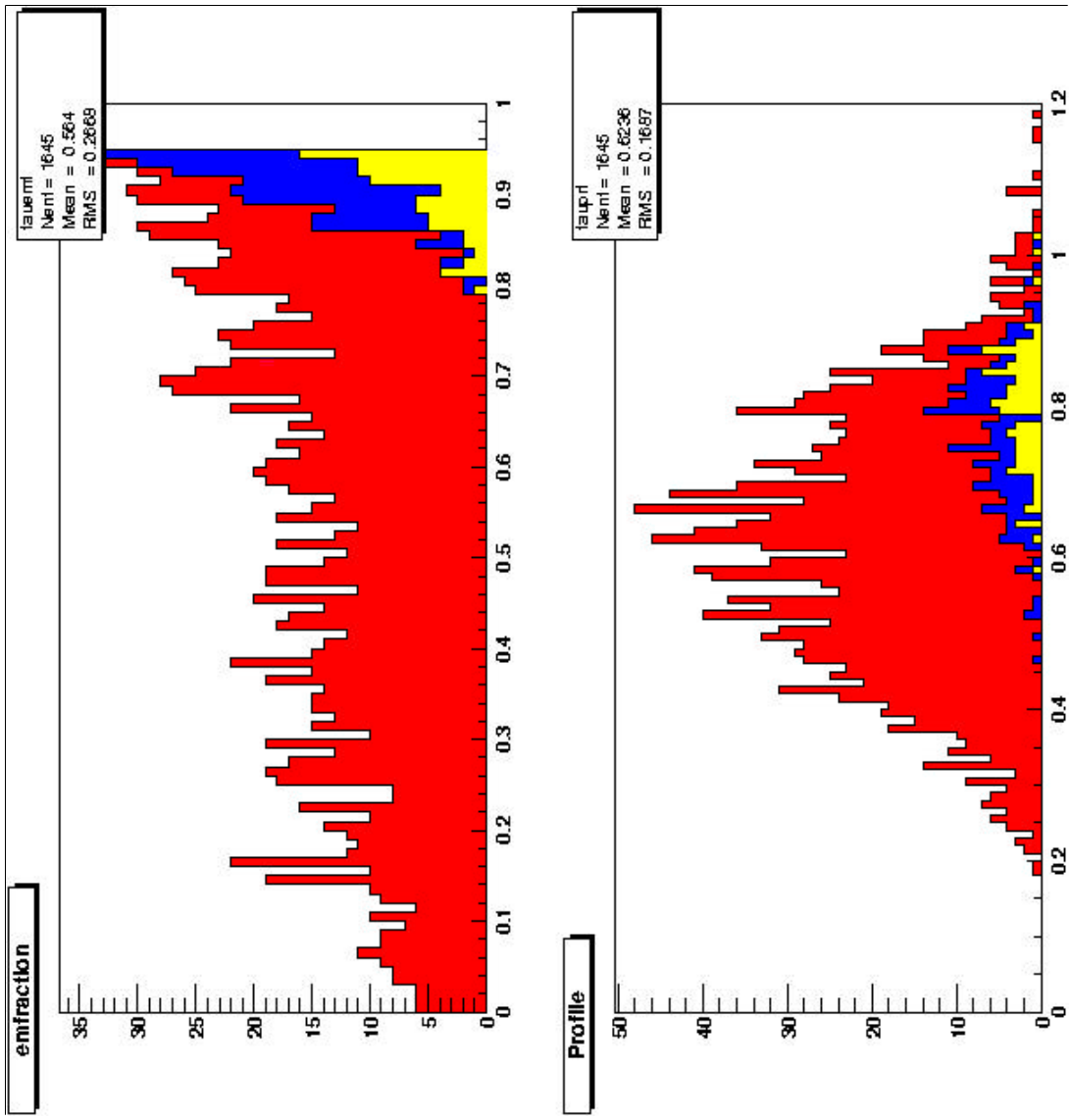
❖ Tau ID

- ❖ New flag word in tau object (FLAG = 1 indicates tau matched to electron)
- ❖ New EM fraction calculation using 0.3 cone (not cut on yet)
- ❖ New profile cut (> 0.25)
- ❖ Retrained H-matrices on events from p05.00.04
- ❖ Added tau MC info and H-matrix info to reco_analyze ntuple.

❖ Jets / MET

- ❖ Minor fixes to jet algorithms
  - ❖ Change longitudinal matching of floor clusters in CellNN to handle EC and CC similarly.
  - ❖ Fix inconsistencies in handling "parton" and "partons".
- ❖ Calculate MET in eta rings with vertex = (0,0,0), to improve ability to handle revertexing

Tau ID


emfraction
tauemf
Nent = 1645
Mean = 0.564
RMS = 0.2869
Profile
taupt
Nent = 1645
Mean = 0.6236
RMS = 0.1687

- **b/c ID**
  - bcJet chunk now persistent (version 1.0)
  - bcjet_analyze part of reco_analyze
  - Five taggers:
    - eTagAlg (semreco)
    - muTagAlg
    - SecVtxAlg
    - JetImpAlg
    - LikelihoodAlg

Performance studies

Some *preliminary* expectations…

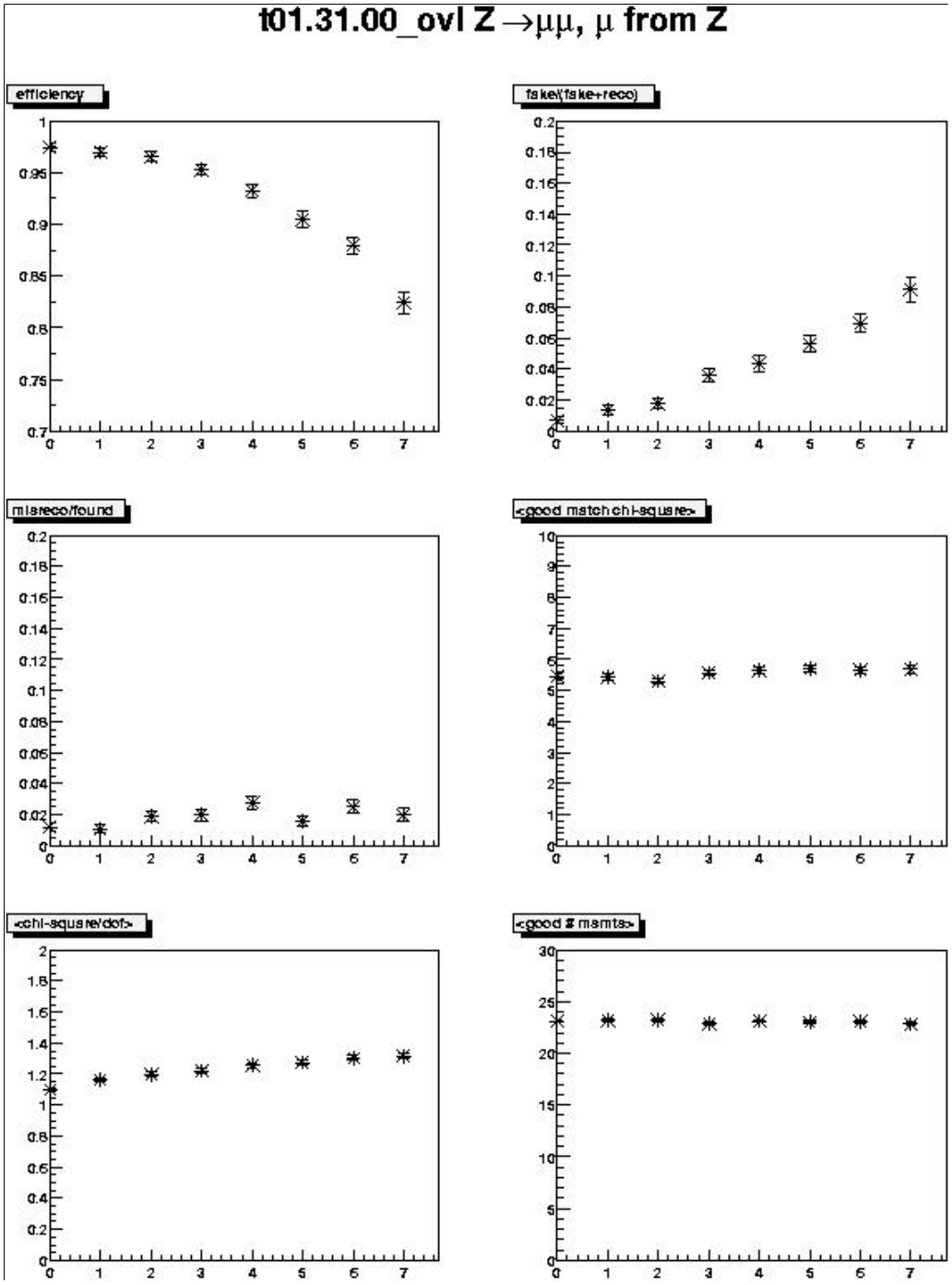
❖ Tracking

❖ Turning on overlap tracking has the effect of raising the tracking efficiency to the high 90's % range for not too heavily populated events, while approximately doubling the CPU time spent in tracking.

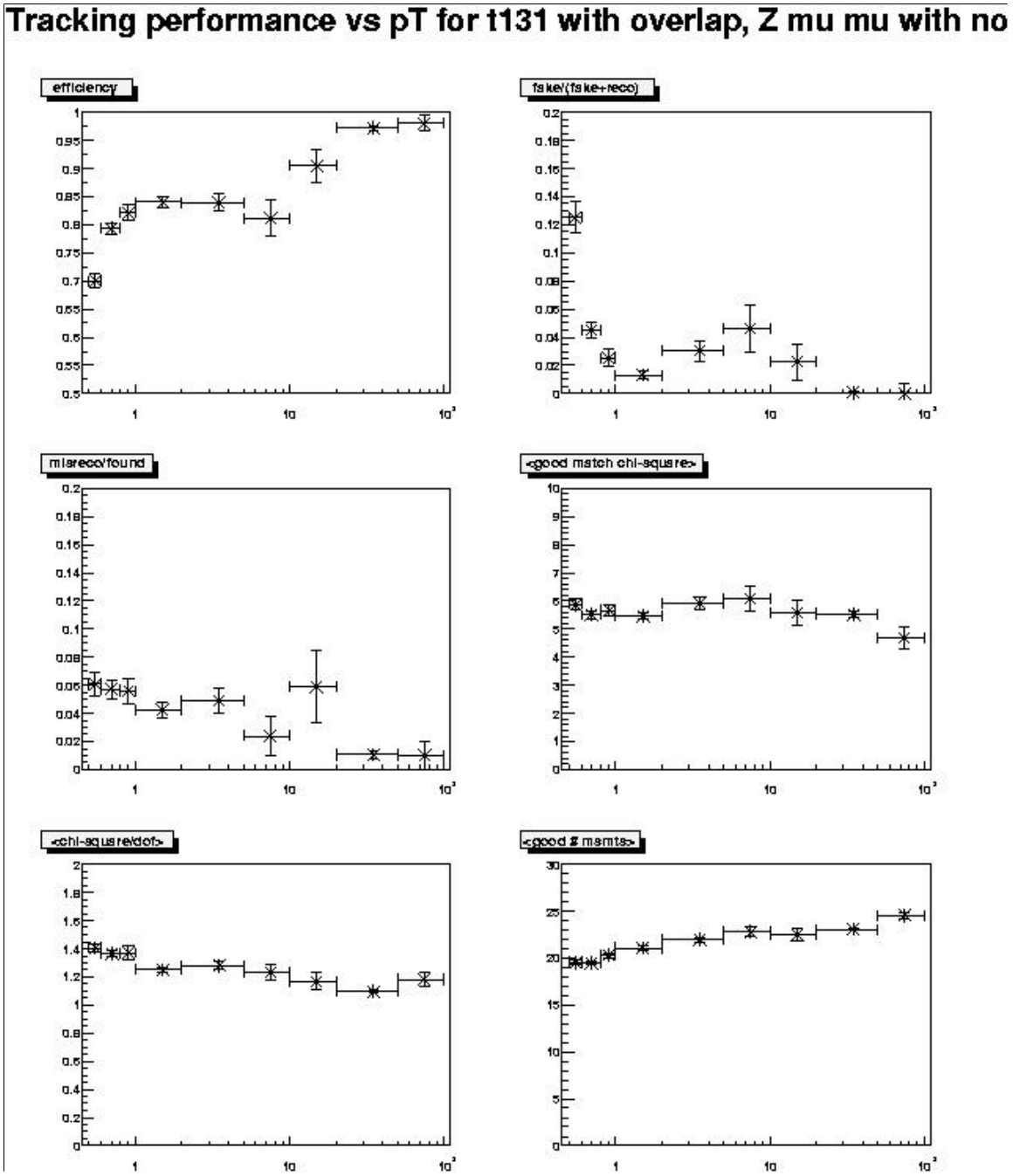
❖ Using the non-uniform magnetic field for track finding in the overlap region, and for refitting in overlap and central region makes a noticeable improvement in fit quality in the overlap and the edges of the CFT central region.

❖ Better accounting for CFT cluster errors has partially solved the observed CFT efficiency drop-off with increasing number of background events. However, there is still an observed drop. Effort is continuing with the impending introduction of a new kind of CFT cluster that has more information about the cluster error.

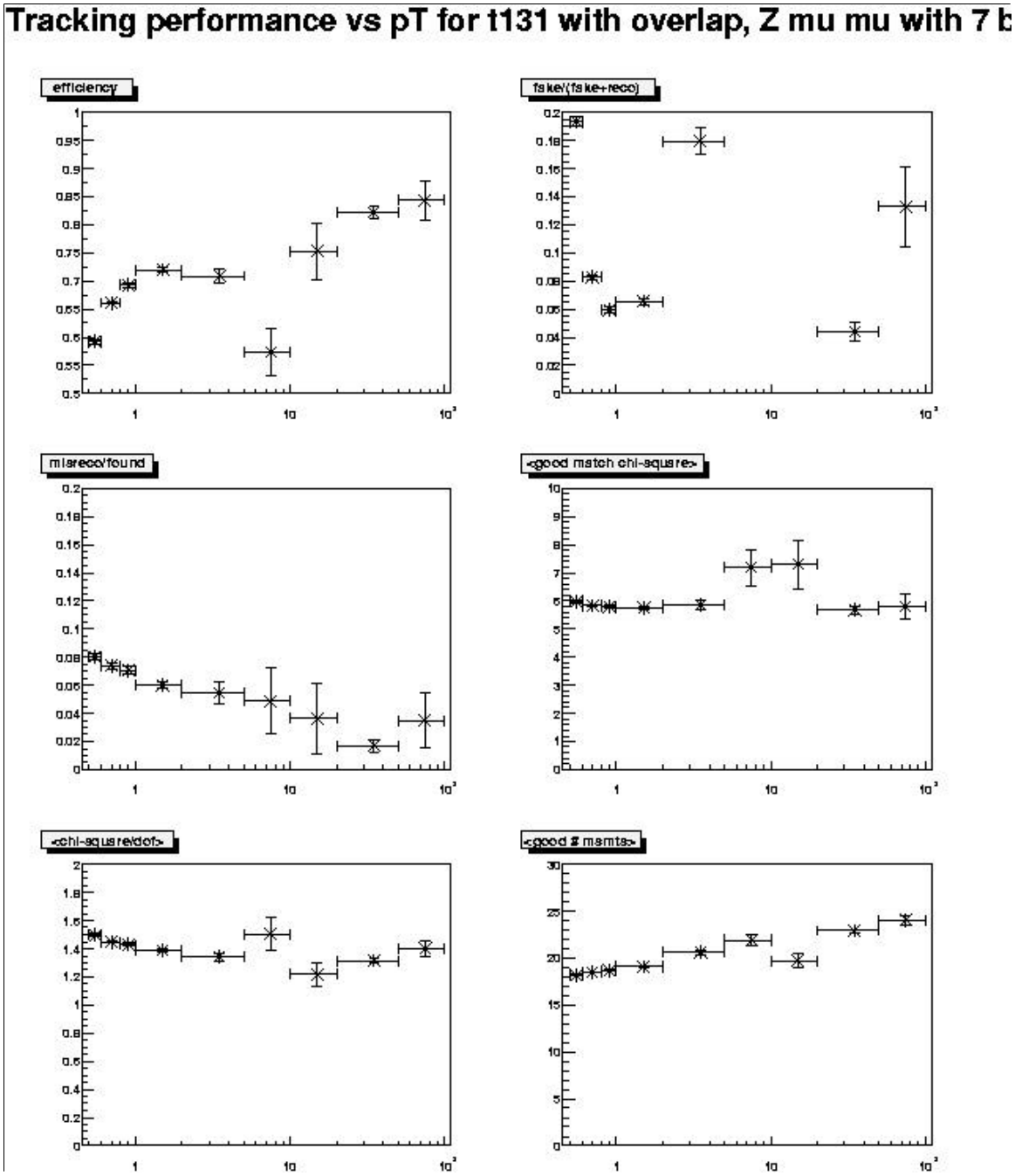
Tracking


t01.31.00_ovl Z→μμ, μ from Z
efficiency
fake/(fake+reco)
misreco/found
<good match chi-squared>
<chi-squared/dof>
<good # mamtchs>

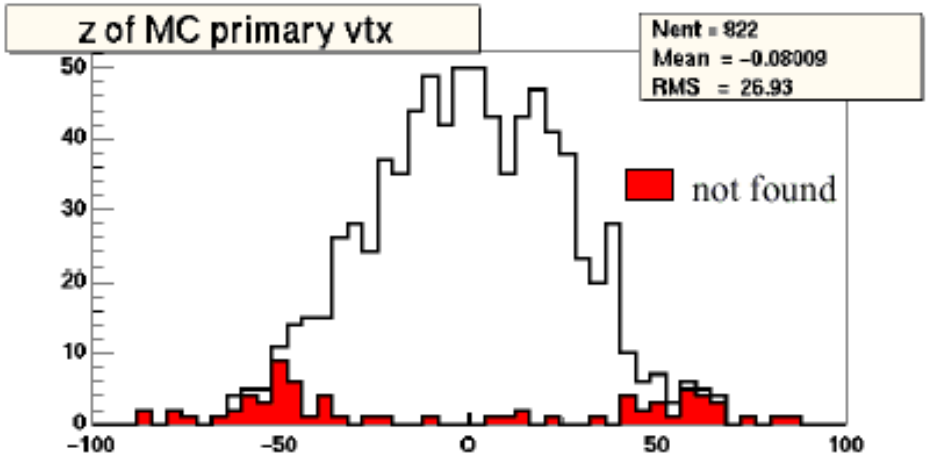
Tracking

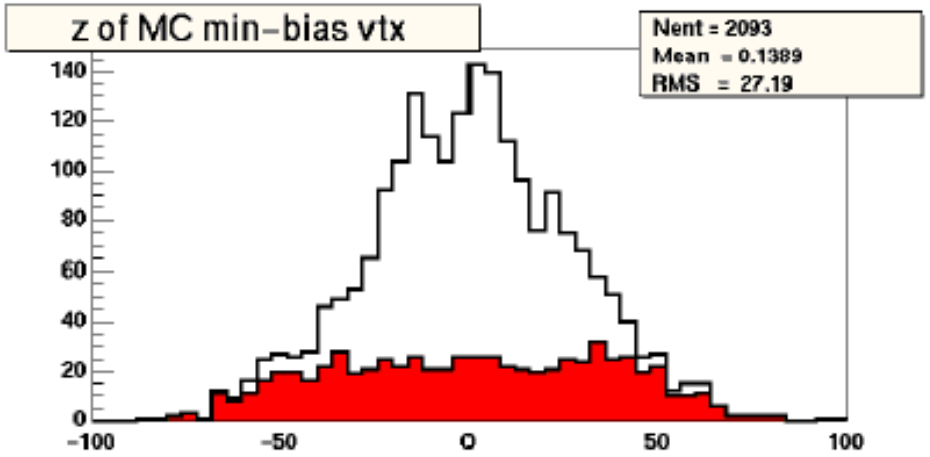

Tracking performance vs pT for t131 with overlap, Z mu mu with no
efficiency
fake/(fake+reco)
misreco/found
<good match chi-squsre>
<chi-squsre/ndof>
<good # msmts>

Tracking


Tracking performance vs pT for t131 with overlap, Z mu mu with 7 b
efficiency
fake/(fake+reco)
misreco/found
<good match chi-square>
<chi-square/ndof>
<good # mamts>

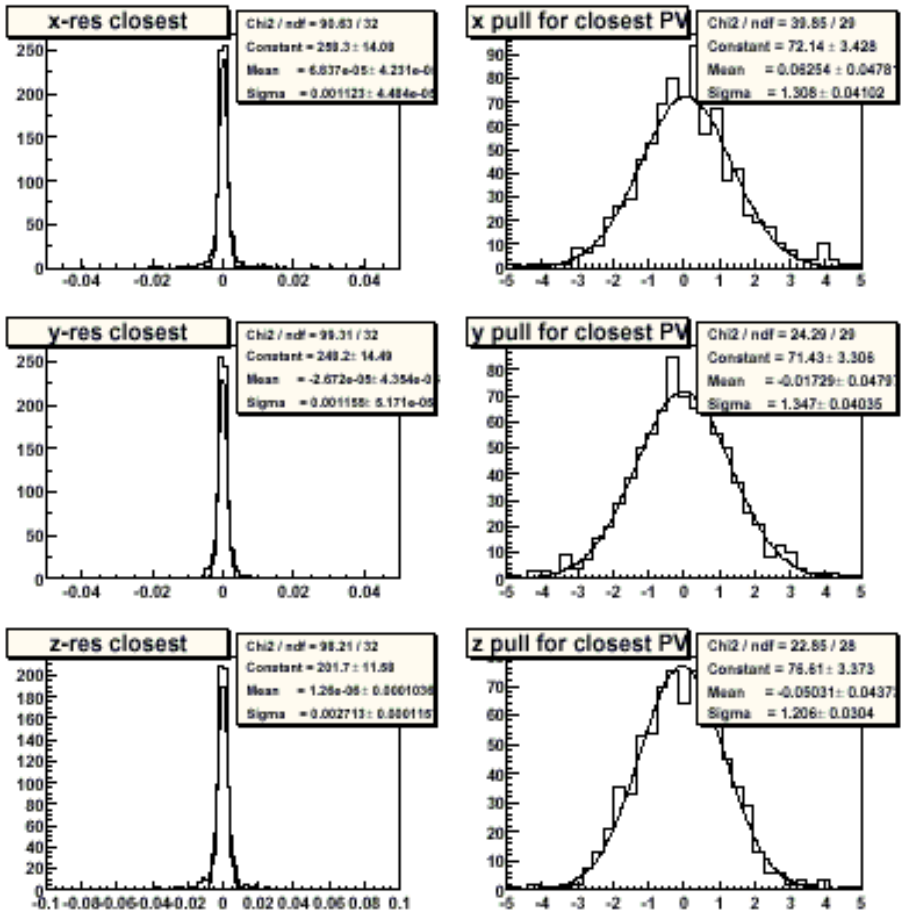
Primary Vertex (tt−bar)





- tt−bar 2.5 min−bias processed through d0reco of t01.31.00 (newer tracking)
- Efficiency for finding the primary vertex: 91%
  - 65% last summer
- For |z|<40 cm 98%
- 68% efficiency for finding min−bias vertex

Primary Vertex Distributions



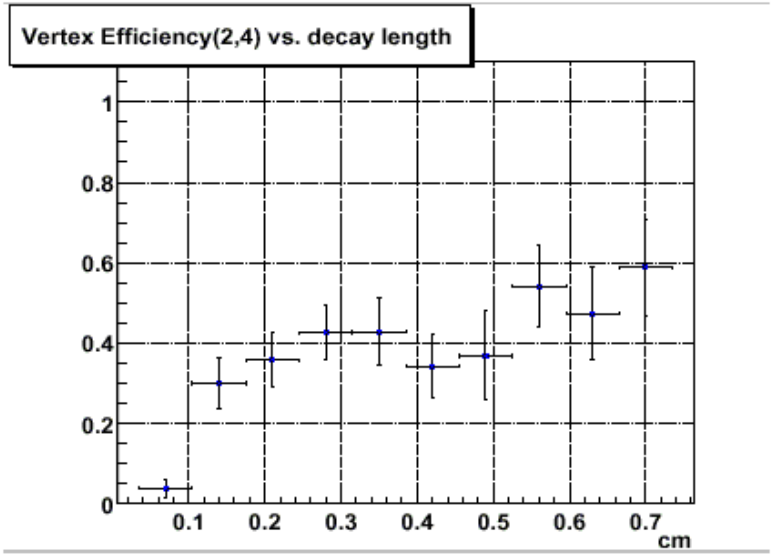
- Resolution
  - 11 micron in x−y
  - 27 micron in z
  - used to be 18 micron (x−y) and 47 micron in z
- Pull distributions are also better: 1.2−1.3 compared to 1.4−1.6 last summer

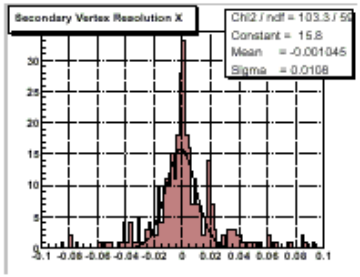
Vertexing

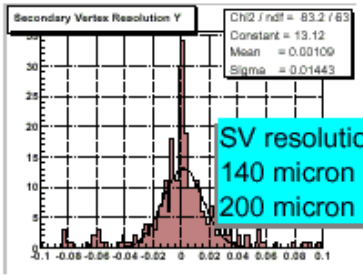
Kalman Vertexing (tt–bar)

overall ε_{b+c} = 34% for finding b or c displaced vertices

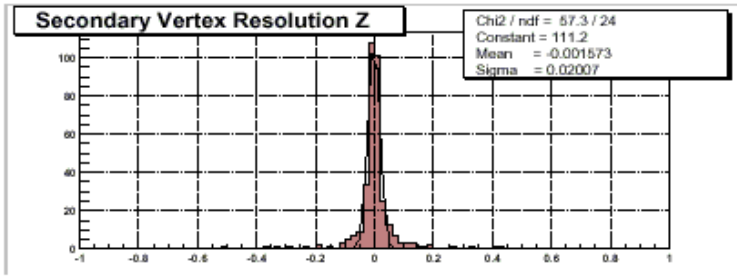
purity = 49%



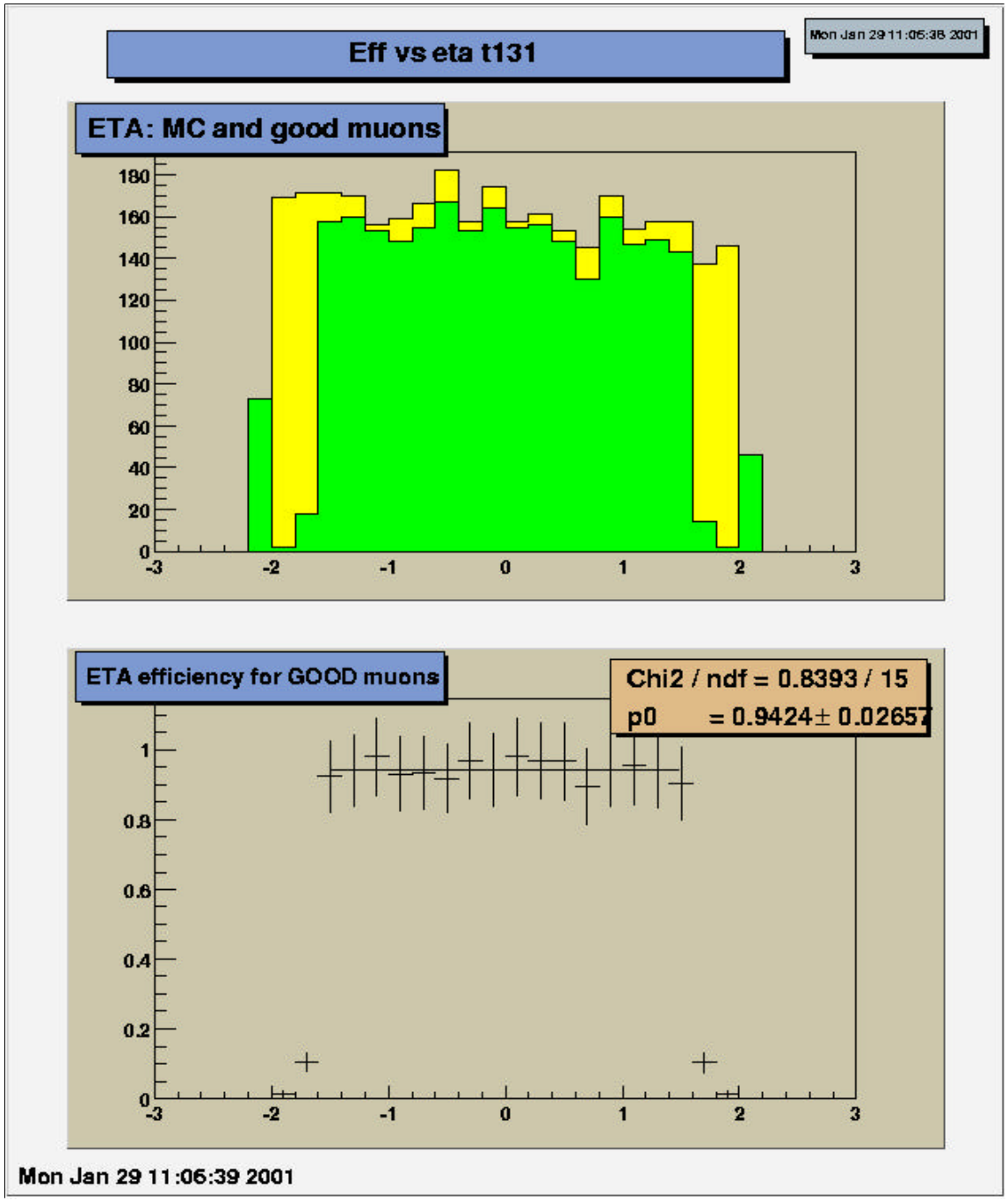




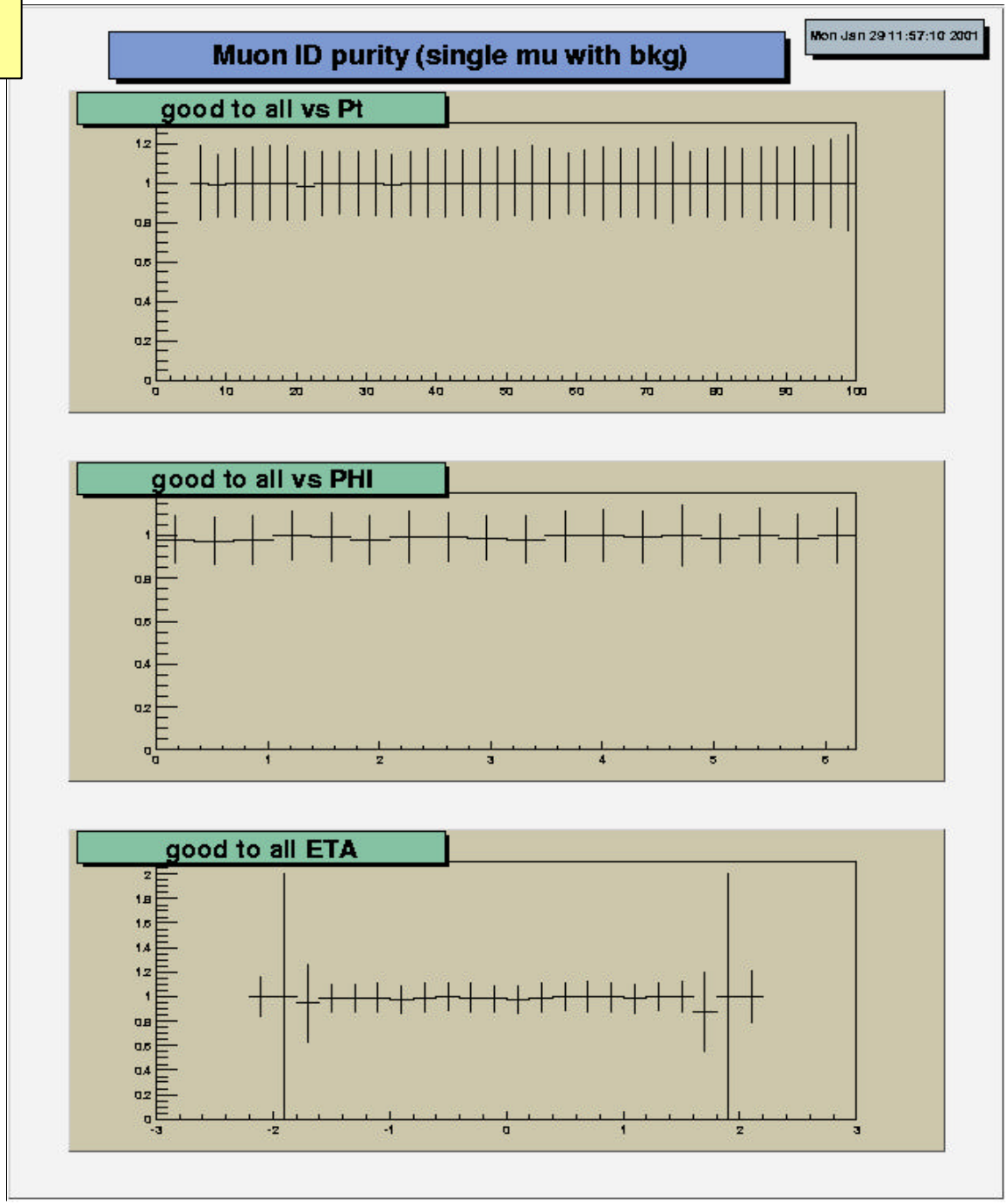
SV resolution
140 micron in x–y
200 micron in z



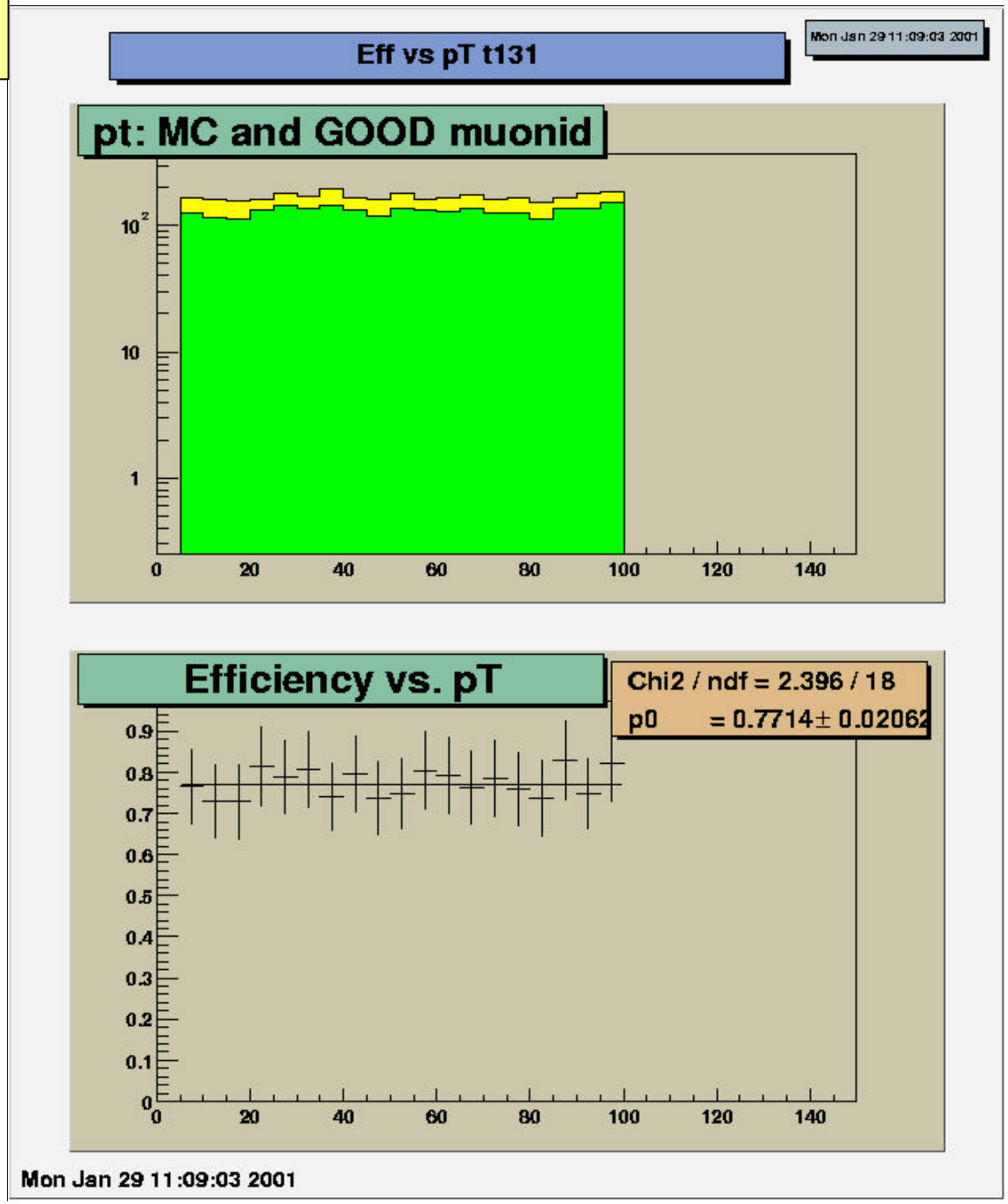
Muon ID


Eff vs eta t131
Mon Jan 29 11:05:38 2001
ETA: MC and good muons
180
160
140
120
100
80
60
40
20
0
-3
-2
-1
0
1
2
3
ETA efficiency for GOOD muons
Chi2 / ndf = 0.8393 / 15
p0 = 0.9424± 0.02657
1
0.8
0.6
0.4
0.2
0
-3
-2
-1
0
1
2
3
Mon Jan 29 11:06:39 2001

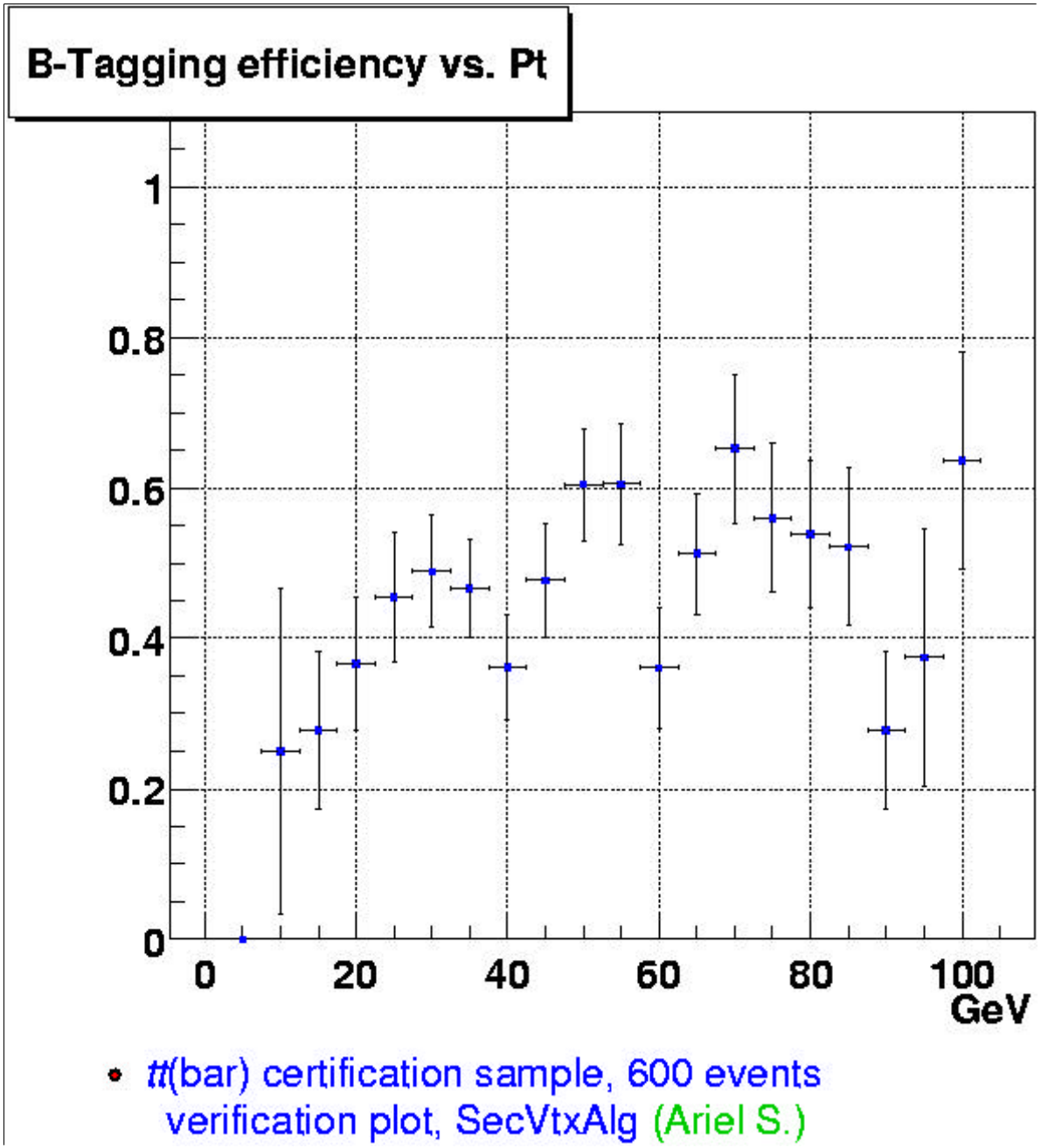
Muon ID


Muon ID purity (single mu with bkg)
Mon Jan 29 11:57:10 2001
good to all vs Pt
good to all vs PHI
good to all ETA

Muon ID

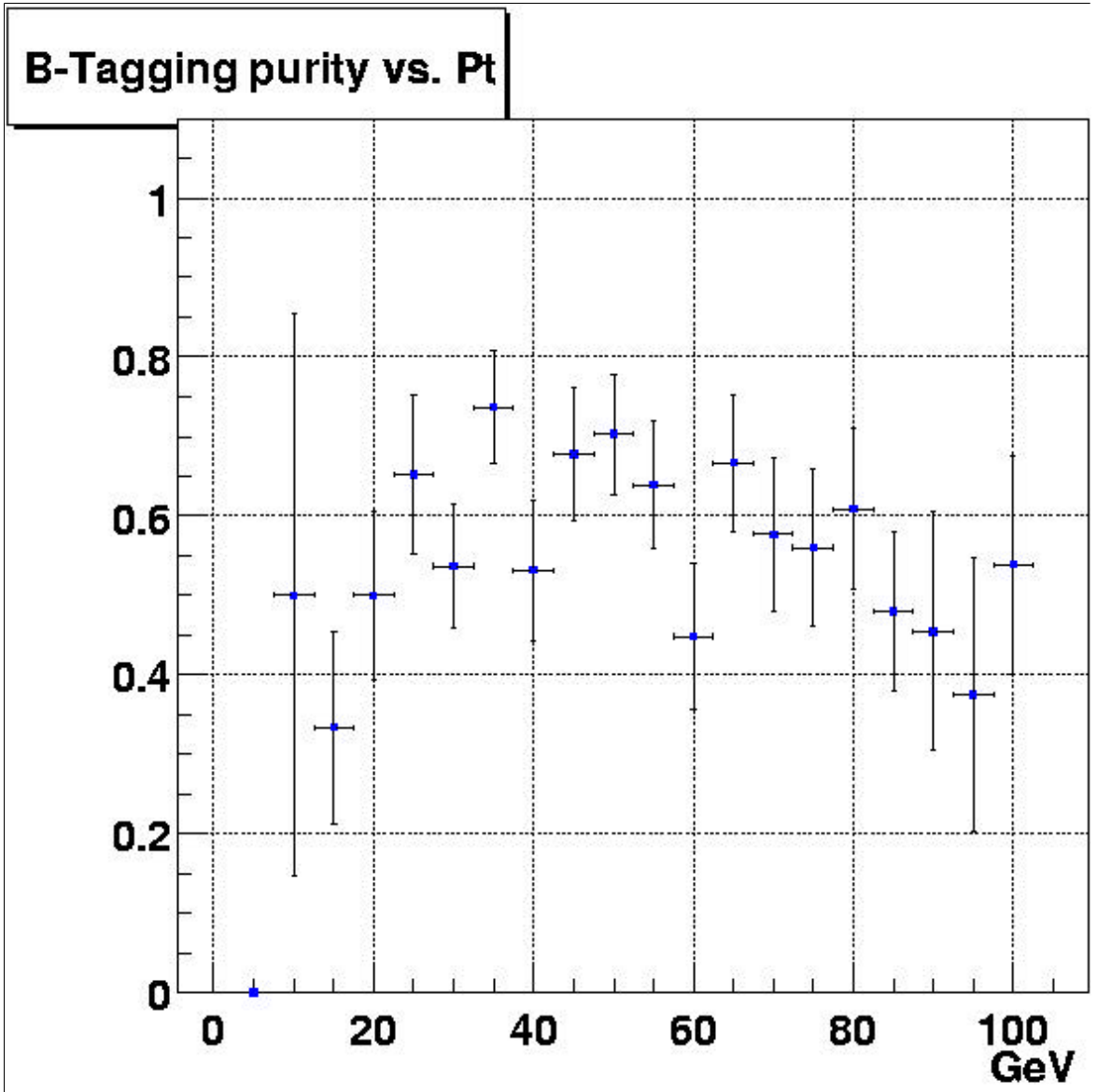

Eff vs pT t131
Mon Jan 29 11:09:03 2001
pt: MC and GOOD muonid
10^2
10
1
0
20
40
60
80
100
120
140
Efficiency vs. pT
Chi2 / ndf = 2.396 / 18
p0 = 0.7714± 0.02062
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140
Mon Jan 29 11:09:03 2001

b/c ID



- *tt*(bar) certification sample, 600 events
  verification plot, SecVtxAlg (Ariel S.)

b/c ID



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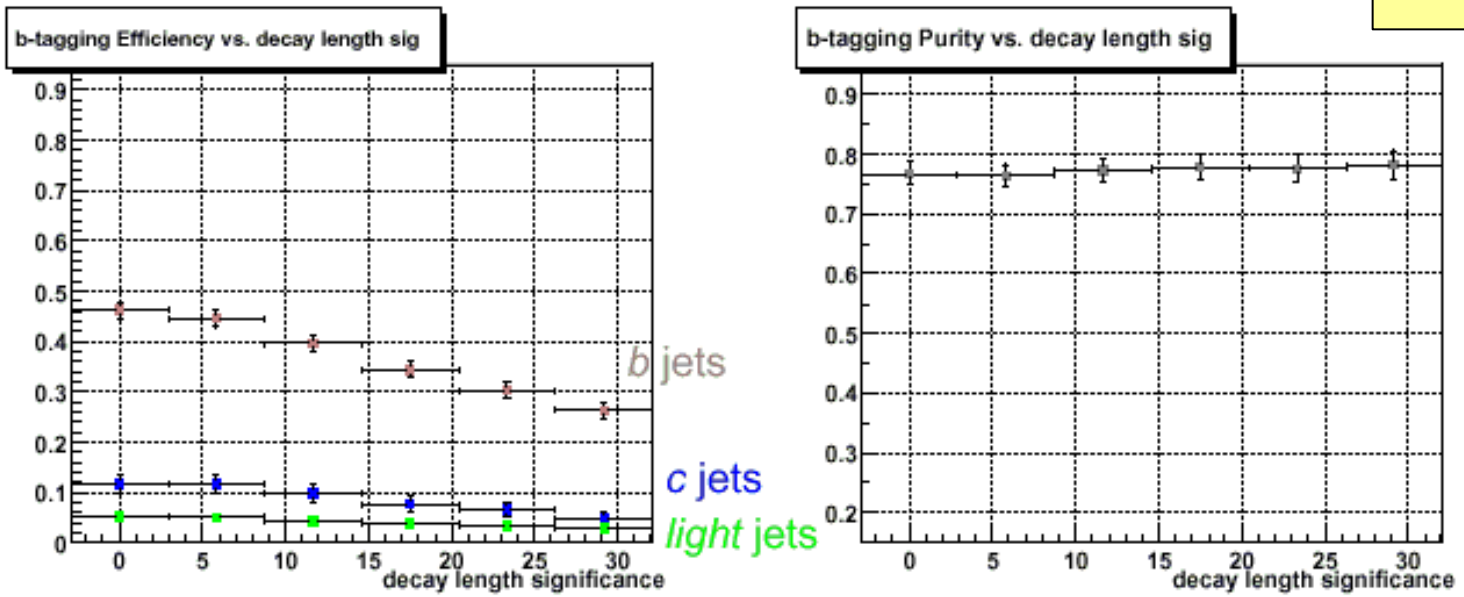
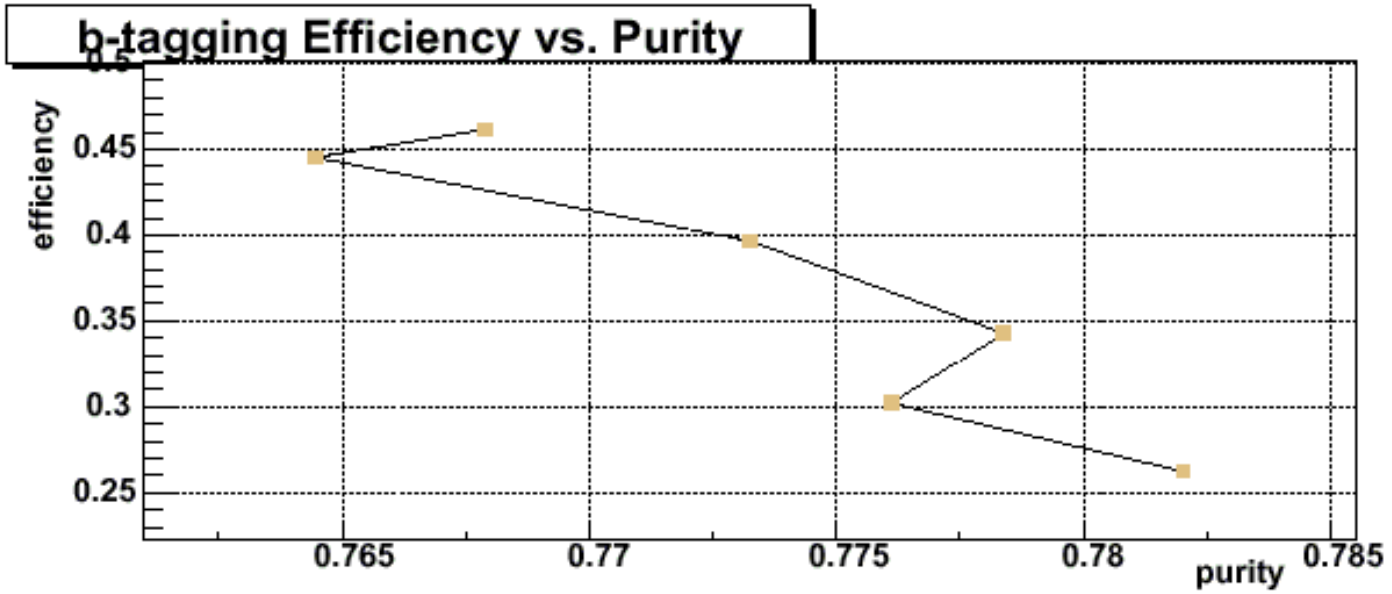
b/c ID


b-tagging Efficiency vs. decay length sig
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
decay length significance
b jets
c jets
light jets

b-tagging Purity vs. decay length sig
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
5
10
15
20
25
30
decay length significance

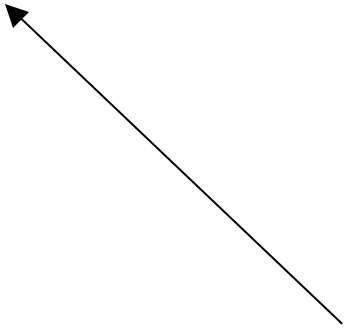

b-tagging Efficiency vs. Purity
efficiency
0.5
0.45
0.4
0.35
0.3
0.25
0.765
0.77
0.775
0.78
0.785
purity

CPU time per stage (**PRELIMINARY**, under investigation)

Measured on IRIX, **non-optimized**, Z(ee) + 2.5 mb avg.

Stage	sec/evt
• init	0.0
• read	0.9
• run_config	0.0
• unpack	0.4
• det	7.0
• gtr	32.7
• vtx	10.3
• pid	125.7
• write	2.5
TOTAL	**182.7**

PID	
• cal	57.5
• chpart	1.2
• em	0.1
• mu	0.1
• jet	41.0
• tau	25.4
• met	0.5



1 year ago:

Z+2: 653 sec/evt, Z+3: 3364 sec/evt

Current status

- Executable exists / runs on IRIX (non-opt)
  - Some serious memory leaks, under investigation
  - Indications are if memory leaks fixed, memory footprint will be ~ 240 Mb
- Test fails on Linux (assert in rcp system)
  - Fingers are crossed

Conclusions

- New version of RECO (p08) almost ready for official certification
- Schedule: certify on Feb. 23
- Status available on Algorithms web page

- Summary of improvements
  - **Major** speed up of tracking
  - Addition of tracking in overlap region
  - Some improvements in tracking effic. vs. luminosity
  - Some improvements in fitting using non-uniform field
  - Improvements in effic / speed for vertexing
  - New vertex algorithms
  - New tool for finding electrons in jets (road method)
  - Sophisticated muon segment object
  - New muon segment algorithm
  - Improved muon local fitting
  - Refined tau id (new H-matrices, profile cut, new EMF calculation)
  - MET in eta rings (to handle revertexing)
  - New b/c chunk